STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

Washington State Energy Code Development

Standard Energy Code Proposal Form

Log No. 122A Rec'd 7/20/21
Revision Rec'd 8/23/21
TAG Revision 8/27/21

Code being amended: ☒ Commercial Provisions ☐ Residential Provisions

Code Section # C407.3, Performance-based compliance, other prescriptive requirements and associated definitions in C202

Brief Description:

Add a definition of *low-carbon district energy exchange system* to C202 and clarify how credit can be claimed in a C407 Total Building Performance analysis for utilizing low-carbon district systems that do plant level heat exchange between buildings.

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

C202 GENERAL DEFINITIONS (add the following definitions, which should be consistently defined if any other district energy exchange related code proposals are adopted):

LOW-CARBON DISTRICT ENERGY EXCHANGE SYSTEM. Any system serving multiple buildings providing energy in the form of a circulated fluid that can accept or reject heat from individual buildings. Energy can be indirectly converted to meet building heating or cooling loads by serving as the heat source or sink for heat-pump systems. Examples include, but are not limited to low temperature condenser water, ground source condenser water, or sewer heat recovery.

~~Documentation for the l~~Low-carbon district energy exchange systems must ~~be available to~~ demonstrate that 25% of the annual district-system-net-load-met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat, or *renewable energy resources* and no more than 25% of the annual heat input to the system comes from fossil fuel or electric-resistance sources.

C404.2.1 High input-rated service water heating systems for other than Group R-1 and R-2 occupancies. In new buildings where the combined input rating of the water-heating equipment installed in a building is equal to or greater than 1,000,000 Btu/h (293 kW), the combined input-capacity-weighted-average efficiency of water-heating equipment shall be no less than the following for each water heating fuel source:

1. Electric: A rated COP of not less than 2.0. For air-source heat pump equipment, the COP rating will be reported at the design leaving heat pump water temperature with an entering air temperature of 60°F(15.6°C) or less.
2. Fossil Fuel: A rated Et of not less than ~~90~~ 92 percent as determined by the applicable test procedures in Table C404.2.

Exceptions:

1. Where not less than 25 percent of the annual service water-heating requirement is provided

from any of the following sources:

1.1. Renewable energy generated on site that is not being used to satisfy another requirement of this code;

or

1.2. Site recovered energy that is not being used to satisfy other requirements of this code.

2. Redundant equipment intended to only operate during equipment failure or periods of extended maintenance.
3. Electric resistance heated systems installed as part of an alteration where the water heating equipment is installed at the grade level in a building with a height of four stories or greater.
4. Hot water heat exchangers used to provide service water heating from a district utility (steam, heating hot water).
5. Water heaters provided as an integral part of equipment intended to only heat or boost the heat of water used by that equipment.
6. For electric heat systems, supplemental water heaters not meeting this criteria that function as auxiliary heating only when the outdoor temperature is below 32°F (0°C) or when a defrost cycle is required are not required to have a rated COP of 2.0. Such systems shall be sized and configured to lock out electric resistance or fossil fuel heating from operation when the outdoor temperature is above 32°F (0°C) unless the system is in defrost operation.
7. Systems connected to a *low-carbon district energy exchange system*.

Commented [ML1]: This exception needs to be added to proposal 136.

C404.2.2 High input-rated service water heating system for Group R-1 and R-2 occupancies. In new buildings with over 1,000,000 Btu/h installed service water heating capacity serving Group R-1 and R-2 occupancies, at least 25 percent of annual water heating energy shall be provided from any combination of the following water heating sources:

Commented [ML2]: Section has been proposed to be removed from C404

1. Renewable energy generated on site that is not being used to satisfy other requirements of this code;

   or

2. Site-recovered energy that is not being used to satisfy other requirements of this code.

Exception: Compliance with this section is not required if the combined input-capacity-weighted average equipment rating for each service water heating fuel source type is not less than the following:

1. Electric Resistance: An electric resistance water heater water with a rating of 105% of the rated efficiency of Table C404.2.
2. Electric Heat Pump (10 CFR Part 430): A heat pump water heater rated in accordance with 10 CFR Part 430 with a rating of 105% of the rated efficiency of Table C404.2.
3. Electric Heat Pump (not listed in accordance with 10 CFR Part 430): A heat pump water heater not rated in accordance with 10 CFR Part 430 shall have a COP of not less than 2.0. For air-source heat pump equipment the COP rating will be reported at the design leaving heat pump water temperature with an entering air temperature of 60°F (15.6°C) or less. Supplemental water heaters not meeting the above criteria that function as auxiliary heating only when the outdoor temperature is below 32°F (0°) or when a defrost cycle is required are not required to have a rated COP of 2.0. Such systems shall be sized and configured to lock out electric resistance or fossil fuel heating from operation when the outdoor temperature is above 32°F (0°C) unless the system is in defrost operation.
4. Fossil Fuels: A rated Et of not less than 90% as determined by the applicable test procedures in Table C404.2.
5. Hot water heat exchangers used to provide service water heating from a district utility (steam, heating hot water).
6. Systems connected to a *low-carbon district energy exchange system*.

C407.3.2 Utilization of low-carbon district energy

C407.3.2.2 Utilization of low-carbon district energy exchange systems. Applicable ~~I~~if heating or cooling is provided to the proposed building from a *low-carbon district energy exchange system* *that is fully operational prior to the final inspection.* ~~,~~ Proposed model shall account for all on-site HVAC and Service Hot Water related equipment, such circulation pump energy and heat-exchanger efficiency.

1. The following modifications ~~are made~~ shall be applied to the ASHRAE Standard 90.1 Appendix G, Performance Rating Method, in addition to what is described in C407.3.
    a. Strike the text of Sections G3.1.1.1, G3.1.1.2, G3.1.1.3, G3.1.1.3.1, G3.1.1.3.2, G3.1.1.3.3, G3.1.1.3.4. Baseline system shall be selected based on un-modified version of Tables G3.1.1-3 and G3.1.1-4, with carbon emission factors from Table C407.3(1).
2. Any heating or cooling energy provided by *low-carbon district energy exchange system* ~~will~~ shall utilize footnote a of Table C407.3(1) for the district system carbon emission factor in the proposed model.
3. ~~Cooling~~ Waste energy exported from the building to the *low-carbon district energy exchange system* shall not be considered purchased energy and shall be ~~subtracted from~~accounted for in the proposed design carbon emissions based on footnote a of Table C407.3(1) at the factors below.
    a. 50% of the ~~cooling energy~~waste heat exported to the *low-carbon district energy exchange system* during the months of October through December and January through March shall be subtracted from the proposed design carbon emissions.
    b. 25% of the ~~cooling energy~~waste heat exported to the *low-carbon district energy exchange system* during the months of April through September shall be subtracted from the proposed design carbon emissions.

    Exception to Item 3: Waste heat exported from the building to the low-carbon district heating and cooling, or heating only system shall not be subtracted from the proposed design carbon emissions if they are already accounted for in the calculation of emissions from the district heating or cooling plant.

Documentation for the *low-carbon district system* that is operational prior to the final inspection shall be provided to demonstrate that the definition of *low-carbon district energy exchange system* is satisfied.

Purpose of code change:

District energy systems which utilize low-carbon fuel sources (which meet or are better than what would have otherwise been built on-site) should be encouraged as a method for achieving the state's targeted carbon emission reductions. Proposed language adds more options for projects that utilize a low-carbon district energy system and wish to utilize the C407 energy code path.

Definition section could be adjusted in future code cycles to reduce the allowable portion of district energy coming from non-renewable or fossil fuel sources.

An important aspect of these energy exchange systems will be ensuring that buildings with diverse loads have incentive to connect to the system; the efficiency and opportunity is greatest with complementary and diverse load profiles so that heat is available to recover when it's needed. Therefore, it's critical for buildings that both need heat and are exporting heat have incentives to connect to the system, as well as a clear path for energy code compliance. In instances where excess load is connected to the system beyond the heat needed, centralized heat rejection is very similar in efficiency to the heat rejection that would have occurred on-site, so there is limited downside, with significant upside potential for the operational system efficiency if additional projects connect that need the heat in the future.

Excerpts from ASHRAE 90.1-2019 for reference:

G3.1.1.1 Purchased Heat

For *systems* using purchased hot water or steam, the heating source shall be modeled as purchased hot water or steam in both the *proposed design* and *baseline building design*. Hot-water or steam costs shall be based on actual utility rates, and on-site *boilers*, electric heat, and furnaces shall not be modeled in the *baseline building design*.

G3.1.1.2 Purchased Chilled Water

For *systems* using purchased chilled water, the cooling source shall be modeled as purchased chilled water in both the *proposed design* and *baseline building design*. Purchased chilled-water costs shall be based on actual utility rates, and on-site chillers and direct expansion *equipment* shall not be modeled in the *baseline building design*.

G3.1.1.3 Baseline HVAC System Requirements for Systems Utilizing Purchased Chilled Water and/or Purchased Heat

If the *proposed design* uses purchased chilled water and/or purchased heat, the following modifications to the baseline *HVAC system* types in Table G3.1.1-4 shall be used.

G3.1.1.3.1 Purchased Heat Only

If the *proposed design* uses purchased heat, but does not use purchased chilled water, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline *HVAC system* type, and purchased heat shall be substituted for the heating type in Table G3.1.1-4. The same heating source shall be used in the *proposed design* and *baseline building design*.

G3.1.1.3.2 Purchased Chilled Water Only

If the *proposed design* uses purchased chilled water but does not use purchased heat, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline *HVAC system* type, with the modifications listed below:

a. Purchased chilled water shall be substituted for the cooling types in Table G3.1.1-4.
b. *System* 1 and 2 shall be constant-volume fan-coil units with *fossil fuel boilers*.
c. *System* 3 and 4 shall be constant-volume single-zone air handlers with *fossil fuel* furnaces.
d. *System* 7 shall be used in place of *System* 5.
e. *System* 8 shall be used in place of *System* 6.

G3.1.1.3.3 Purchased Chilled Water and Purchased Heat

If the *proposed design* uses purchased chilled water and purchased heat, then Tables G3.1.1-3 and G3.1.1-4 shall be used to select the baseline *HVAC system* type, with the following modifications:

a. Purchased heat and purchased chilled water shall be substituted for the heating types and cooling types in Table G3.1.1-4.
b. *System* 1 shall be constant-volume fan-coil units.
c. *System* 3 shall be constant-volume single-zone air handlers.
d. *System* 7 shall be used in place of *System* 5.

G3.1.1.3.4 On-Site Distribution Pumps

All on-site distribution pumps shall be modeled in both the *proposed design* and *base building design*.

Your amendment must meet one of the following criteria. Select at least one:

☐ Addresses a critical life/safety need.

☐ The amendment clarifies the intent or application of the code.

☒ Addresses a specific state policy or statute. (Note that energy conservation is a state policy)

☐ Consistency with state or federal regulations. ☐ Corrects errors and omissions.

☐ Addresses a unique character of the state.

Check the building types that would be impacted by your code change:

☐ Single family/duplex/townhome ☒ Multi-family 4 + stories ☒ Institutional

☐ Multi-family 1 – 3 stories ☒ Commercial / Retail ☐ Industrial

Your name	Clarence Clipper	Email address	clarence.clipper@centrioenergy.com
Your organization	Centrio	Phone number	206-658-2026

Other contact name Click here to enter text.

Instructions: Send this form as an email attachment, along with any other documentation available, to: sbcc@des.wa.gov. For further information, call the State Building Code Council at 360-407-9278.

Economic Impact Data Sheet

Briefly summarize your proposal's primary economic impacts and benefits to building owners, tenants and businesses.

A significant economic benefit of this proposal is that it introduces more options for energy code compliance for projects which invest in systems that provide long-term lower carbon operation.

Depending on the specifics, the on-site equipment is likely less expensive than a stand alone plant (if heat pump provisions are adopted). Buildings that primarily "add" heat to a district energy exchange system largely benefit in freeing up roof space and capital cost that would be required for heat rejection equipment, as well as eliminating potential cooling tower plume concerns at the site. Buildings that "pull" heat from the district energy system will likely utilize equipment to extract the heat from the condenser water loop (often Water-to-Water Heat Pumps (WWHP)) which is likely less expensive than an all-on-site plant which may include Air-to-Water Heat Pumps and backup electric boilers and associated electrical service increase.

This proposal creates a viable energy code compliance path to enable projects with diverse/complimentary load profiles to exchange energy beyond the footprint of their sites on a utility scale instead of requiring owner-to-owner negotiations.

Provide your best estimate of the construction cost (or cost savings) of your code change proposal? (See OFM Life Cycle Cost **Analysis tool** and **Instructions;** use these **Inputs**. **Webinars on the tool can be found Here and Here**)

$0.50-$2.00 ROM Capital Cost savings/square foot

(For residential projects, also provide $Minimal cost impact in units – capital cost impacts for central equipment / dwelling unit)

Show calculations here, and list sources for costs/savings, or attach backup data pages

Buildings that primarily "add" heat to a district energy exchange system largely benefit in freeing up roof space and capital cost that would be required for heat rejection equipment.

Buildings that "pull" heat from the district energy system will likely utilize equipment to extract the heat from the condenser water loop (often Water-to-Water Heat Pumps (WWHP)) which is likely less expensive than an all-on-site plant which may include Air-to-Water Heat Pumps and backup electric boilers and associated electrical service increase.

Provide your best estimate of the annual energy savings (or additional energy use) for your code change proposal?

See energy discussion below - Highly dependent upon connected building loads) KWH/ square foot (or) KBTU/ square foot

(For residential projects, also provide KWH/KBTU / dwelling unit)

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

Energy modeling of projects that have both office and residential towers on immediately adjacent sites (and thus can implement direct energy exchange between the cooling dominated offices and heating dominated residences), shows that there is a significant increase in heat recovery potential when the projects can exchange energy compared to any heat recovery available within each individual project. For example, a stand-alone residential tower might be able to meet ~10-15% of its gross annual heating load (space heating, DHW, pool etc) from on-site recovered heat (cooling). However, when connected to an equivalent sized office tower, with year-round heat-rejection needs, 40-60% of the gross heating load can be met by heat-recovery equipment.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.

Given a source of heat, such as district energy exchange systems, water-to-water-heat-pumping can operate significantly more efficiently than air-to-water-heat-pumping (COPs of 5-7 instead of COPs of 2-3). Thus there is a big site energy "win" for heating dominated buildings to use heat recovery options as the first stage of heating before utilizing even AWHPs.

The exact energy savings that can be expected vary significantly based on the exact project type and balance of loads on a given energy exchange system, and there may be times when heat must be added by district equipment to maintain a minimum loop temperature. That is why this proposal introduces language to define a "low carbon district energy system" with minimum % of heat that must come from heat-recovery and maximum % of heat that can come from fossil fuels or electric resistance (values that can be modified by the TAG or in future code cycles). This would ensure that the energy code is only encouraging the most efficient district energy recovery schemes while still allowing projects to gain the design flexibility introduced by connecting to such systems. The minimal allowance for fossil fuel or electric resistance inputs gives some flexibility for these large-scale systems to ramp up to full operation (year-one load balance might not be significantly different than the established system operation).

List any code enforcement time for additional plan review or inspections that your proposal will require, in hours per permit application:

Having a clear set of rules for C407 energy modeling on these systems reduced the amount of project specific negotiations required by code officials. The overall project review times should be similar to any project utilizing a Total Building Performance analysis compliance approach. The district system provider will have to work with code officials to initially establish that their system meets the low carbon designation, thus opening the door for projects to connect and take advantage of the proposed code language.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.